Summer 2015

AP Chemistry: Bonding + Periodic Table Review + Extension [11th-12th grade]

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AP Chemistry: Bonding Review + Extension

Grade Level: 11th or 12th grade (second year of chemistry)

Subject: AP Chemistry

Designed By: Katie Whittaker

Time Frame: 1-2 weeks

School District: Northside ISD

School: Health Careers High School

School Address and Phone: 4646 Hamilton Wolfe Rd, San Antonio, TX 78229; 210 397-5400

<u>Brief Summary of Unit</u> (Including curricular context and unit goals):

This AP Chemistry unit is designed to review bonding from first year chemistry and extend the content into AP bonding objectives. After first year chemistry, this unit attempts to place the bonding content within an intriguing context: smells + how humans sense smells. Our olfactory receptors are activated nearly exclusively by medium-sized, polar molecules. This allows the teacher to draw a distinction between covalent molecules and ionic formula units, polar and nonpolar molecules, and size and shape of molecules predicted from Lewis Dot structures and valence-shell electron-pair repulsion (VSEPR) theory. The unit concludes with a thin-layer chromatography (a separation technique based upon polarity and attraction between molecules and the chromatography paper) performance task in which students design a procedure to separate and identify the dyes in M&Ms candies.

<table>
<tr><th colspan="3">Stage 1 – Desired Results</th></tr>
<tr><td rowspan="6">Established Goals (e.g., standards)

AP Big Ideas & Enduring Understandings with AP Chemistry teacher Denise DeMartino's (http://whsddemartino.weebly.com/) Learning Objectives for Dummies

The atoms of each element have unique structures arising from interactions between electrons and nuclei.
1. Electron configuration of atoms and ions
2. Ionization energy (single and multiple)
3. Coulomb's law
Elements display periodicity in their properties when the elements are organized according to increasing atomic number. This periodicity can be explained by the regular variations that occur in the electronic structures of atoms. Periodicity is a useful principle for understanding properties and predicting trends in properties. Its modern-day uses range from examining the composition of materials to generating ideas for designing new materials.
4. Periodicity</td><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Students will independently use their learning to…
• Apply the scientific method to investigate daily life
• Integrate and apply knowledge from multiple chemical approaches to formulate opinions, make decisions, and take actions</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><td>Understandings
• Science is a way to understand and interpret the universe
• Scientific data must be interpreted by individuals
• The same set of scientific data may be interpreted and analyzed differently for application to different questions or problems
• No understandings in science are absolute but change with further data, different experimentation, novel approaches, and other scientists</td><td>Essential Questions
• Why should I study chemistry?
• How and why does the study of chemistry influence our world and our world influence the study of chemistry?
• How can an understanding of chemistry affect and improve my life?
• Why is is valuable to solve problems that already have answers (i.e. AP questions with definite correct and incorrect responses)?
• Why is it important to analyze data that has already been interpreted?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><td>Knowledge
Students will know…
• The key attributes of covalent, ionic, and metallic bonds
• The definitions of isotopes and ions
• The definition of periodicity in relation to the periodic table</td><td>Skills
Students will be able to…
• Drawing Lewis Dot structures of covalent compounds
• Determining the polarity of a compound from a molecular formula, drawing, model, or Lewis Dot structure
• Using polarity to predict the strength and type of intermolecular interactions between compounds</td></tr>
</table>

5. Reactivity 6. Using trends to predict properties Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them. 7. Properties based on chemical formula Matter can be described by its physical properties. The physical properties of a substance generally depend on the spacing between particles (atoms, molecules, ions) that make up the substance and the forces of attraction among them. 8. Chromatography based on IMF 9. Solute/solvent interactions (models) **10. Separation techniques** (filtration, paper chromatography, column chromatography, or distillation) Forces of attraction between particles (including the noble gases and also different parts of some large molecules) are important in determining many macroscopic properties of a substance, including how the	● Why periodicity is illuminating + instructive to the study of chemistry ● The Ionization Energy, Atomic Radius, and Electronegativity trends across the periodic table ● The definitions of first, second, etc. Ionization Energy ● The relative Atomic Radii of an atom and its anion or cation ● Reactivity trends across the periodic table ● Electron configurations represent probable locations of electrons relative to the nucleus	● Determining electron configurations of atoms ● Determining electron configurations of ions ● Using the periodicity of the periodic table to determine like properties

observable physical state changes with temperature. 11. Properties affected by LDF 12. IMF H-bond and dipole dipole 13. Coulomb's interactions and solubility (qualitatively) 14. Like dissolves like 15. Physical properties due to IMFs The strong electrostatic forces of attraction holding atoms together in a unit are called chemical bonds. 16. Bond type (based on table location and EN) 17. Rank bond type (polarity) based on periodic table 18. Drawings of ionic properties (boiling point, solubility, hardness, brittleness, low volatility, lack of malleability, ductility, or conductivity, etc.) 19. Metallic models to explain macroscopic properties (conductivity, malleability, ductility, and low volatility, etc.) 20. Lewis Dot and VSEPR The type of bonding in the solid state can be deducted		

from the properties of the solid state. **21. Determine bond type of solid with data** (vapor pressure, conductivity as a solid and in aqueous solution, and relative brittleness or hardness) 22. Draw ionic structures 23. Explain drawings of ionic structures 24. Alloys (properties and types) 25. Use electron sea model to explain metallic properties 26. Draw metallic structures 27. Explain drawings of metallic structures 28. Draw network covalent solids 29. Explain drawings of network covalent solids 30. Draw molecular solids 31. Explain drawings of molecular solids *****Note**: objectives in bold require lab-based instruction*		

Stage 2 – Evidence

CODE	**Evaluative**	

(M or T)	**Criteria** (for rubric)	
M + T A M A + M A M M + A	In a lab report: background, hypothesis, procedures, data, and analysis (rubric follows)	Performance Task(s) *Students will demonstrate meaning-making and transfer by…* Separating M&M Dyes: Guided Inquiry Lab Adapted from: Amoranto, Armand. "AP® Chemistry Course Planning and Pacing Guide 4." AP Central: AP Chemistry Course Home Page. College Board, 2013. Web. 8 June 2015. After an introduction to chromatography and a teacher demonstration of thin-layer chromatography, students use thin-layer chromatography to separate the dyes in M&Ms candies. In groups, students will design a procedure to separate the dyes within M&Ms, compare the dyes within different colors of M&Ms, and attempt to identify the dyes by comparison with provided food colorings. Students ought to calculate and use R_f values throughout this process. Materials: M&Ms, various beakers, deionized water, chromatography paper, sticks, tape, pencil, food colorings --- Other Evidence (e.g., formative) - Smelling Stations guided worksheet - Smelling Stations extension to unknown scent - Lewis Dot structure + VSEPR theory geometry practice + activities - Conductivity + other tests to determine bond type - Build-Your-Own Periodic Table activity + follow-up questions - Electron locations + electron configurations activity + practice

Stage 3 – Learning Plan

CODE (A, M, T)	Pre-Assessment
A M A	*How will you check students' prior knowledge, skill levels, and potential misconceptions?* 1. Summer assignment 2. *Why do bonds form? + What are bonds?* Think-Pair-Share 3. Periodic Table 3-minute write

M	**Learning Activities** (smelling context and related activities adapted from: Stacy, Angelica. Living by Chemistry. 1st ed. New York: National Science Foundation, 2012. Print.) **Day 1 (block schedule):** 1. *Why do bonds form? + What are bonds?* Think-Pair-Share a. Individually, students will reflect on the questions. Students must all jot down at least one idea in response to each question. As pairs or in tables of four, students will share their ideas. Within each grouping, students will then synthesize a response to each question to share with the class. b. During class discussion, the teacher will ensure the following points are discussed or mentioned by the teacher: i. Simplified, a bond involves some sort of electron interactions. The bond itself is attraction between particles that allow those distinct particles to behave as a unit. McCormick, René. "AP* Chemistry Chemical Bonding & Molecular Structure." National Math Science Initiative, 2008. Web. 8 June 2015. ii. Enthalpy + entropy are the driving forces of our universe: to be discussed in much more depth later iii. Energy is released when bonds are formed, energy is consumed to break bonds: ***always***. Therefore, it requires more energy to exist alone than bonded to other atoms. iv. To understand why bonds form, we must have a solid foundation of what bonds are and how to discuss them with others using the common language of chemistry v. In this class, we will review the ideas surrounding bonding within the context of ***smells***. As you	Progress Monitoring (e.g., formative data) Teacher will circulate during discussion, asking thought-provoking questions and redirecting, as necessary. If necessary, the teacher may also collect the written Think-Pair-Share.

	may already know, the chemical composition of molecules dictates the scent we register.	
M	2. The teacher will set up the following ***smelling stations***. At each station, place a cover over the object (compelling students to identify only by smell) and label the station with the chemical name, formula, and chemical grouping. a. Strawberries, hexyl butanoate, $C_{10}H_{20}O_2$ (ester) Negri, Alfredo, Domenico Allegra, and Laura Simoni. "Comparative Analysis of Fruit Aroma Patterns in the Domesticated Wild Strawberries "Profumata Di Tortona" (F. Moschata) and "Regina Delle Valli" (F. Vesca)." Front Plant Sci. 6.56 (2015). National Center for Biotechnology Information, U.S. National Library of Medicine. Web. 10 June 2015. b. Fish (cooked), trimethylamine, C_3H_9N (amine) c. Lillies, linalool, $C_{10}H_{18}O$ (alcohol) d. Lavender oil, linalool, $C_{10}H_{18}O$ (alcohol) + linalyl acetate $C_{12}H_{20}O_2$ (ester) e. Roses, ionone, $C_{13}H_{20}O$ (ketone), damascenone $C_{13}H_{18}O$ (ketone) f. Violets, ionone, $C_{13}H_{20}O$ (ketone), dihydroionone, $C_{13}H_{22}O$ (ketone) Brunning, Andy. "The Chemical Compounds Behind the Smell of Flowers." Compound Interest. 2015. Web. 10 June 2015. g. Peppermint, menthol, $C_{10}H_{20}O$ (alcohol) h. Apple fragrance, ethyl pentanoate, $C_7H_{14}O_2$ (ester) i. Basil, citronellol, $C_{10}H_{20}O$ (alcohol) j. Shrimp (cooked), diisobutylamine, $C_8H_{19}N$ (amine) "Diisobutylamine." The Dictionary of Substances and Their Effects: E-J. Ed. S. Gangolli. 2nd ed. Vol. 3, D. Royal Society of Chemistry, 1999. 491. Print.	
M	3. In pairs or tables of four, students will visit each station, describe the smell, and attempt to identify the object. After	The teacher will monitor students' categories, ensuring the categories are neither too specific nor too

	visiting each station, the students will attempt to categorize the scents into broader smell classifications. The guiding worksheet is attached. a. Using the guiding worksheet, students will look for patterns between the chemical formula, type of compound, and smell. Students should note some of the following: i. All compounds contain carbon and hydrogen. ii. All compounds contain more hydrogen than carbon. If oxygen or nitrogen are present, there are fewer nitrogen or oxygen atoms than hydrogen or carbon. iii. All compounds are molecules (covalently-bonded non-metals). iv. Amines and/or compounds containing nitrogen smell fishy. v. Compounds with oxygen smell more pleasant than compounds with nitrogen. vi. Within the compounds with oxygen, alcohols (usually) smell more woody or earth than the esters or ketones. vii. Within the compounds with oxygen, esters smell more fruity and more floral than the alcohols. The esters smell more fruity (but not more floral) than the ketones. viii. Within the compounds with oxygen, ketones (usually) smell more floral than the esters and alcohols. b. Students will then note any questions they now have about chemical composition and sense of smell.	broad to draw conclusions about smell related to chemical formula.
T	4. Students will predict the smell of a substance compounds of multiple compounds based on its chemical formulas and compound types.	Students will draw Lewis Dot structures for homework; the teacher will grade and comment on the homework. As necessary, the teacher will check-in with and provide

	a. Draw Lewis Dot structure of trimethylamine, explain the value of Lewis Dot structures, predict the polarity of the compound, and explain why the smell of fish doesn't easily wash away with water.	additional practice and/or tutoring for students.
M A M A	**<u>Day 2 (block schedule)</u>:** 1. Concept Attainment activity: teacher will present medium-sized, polar molecules that have a detectable smell to humans and a variety of sized, nonpolar molecules that do not have a detectable smell to humans 2. Students will engage in Lewis Dot structures + polarity practice, either in the classroom with 3. Students will engage in bubbles bonding activity to illustrate VSEPR (reference: Robertson, William. Stop Faking It! Finally Understanding Science So You Can Teach It: More Chemistry Basics. Pg 50. Arlington: National Science Teachers Association, 2010. Print.). 4. Students will practice relating Lewis Dot structures to molecular shapes through VSPER theory	The teacher will circulate around the room, redirecting and supporting students as necessary.
M T	**<u>Day 3 (block schedule)</u>:** 1. Demonstrate the deflection of water by electrically charged balloon activity and discuss the effect of polarity and charges on interactions between molecules. 2. The teacher will introduce chromatography, specifically thin-layer chromatography. The teacher will explain that chromatography separations are based on polarity-based interactions. 3. In heterogeneous groupings, students will begin designing thin-layer chromatography lab to separate and identify the dyes in M&Ms candies.	The teacher will circulate around the room, redirecting and supporting students as necessary.
T	**<u>Day 4 (block schedule)</u>:** 1. Chromatography Lab Performance Task: The unit begins to conclude with a thin-layer chromatography (a separation technique based upon polarity and attraction between molecules and the chromatography paper) performance task in which students design a procedure to separate and identify the dyes in M&Ms candies.	The teacher will circulate around the room, redirecting and supporting students as necessary.

	2. At the end of class, students will individually engage in a 3-minute write about what they know about the periodic table.	
	<u>Day 5 (block schedule)</u>:	
M + A	1. To relate covalent bonds predominantly discussed so far, conductivity + other tests will be used to determine bond type. The teacher will review the bond types and properties as necessary. Students will discuss why thin-layer chromatography can separate various molecules, but not other types of bonded compounds.	
M	2. In groups or individually, students will engage in a Build-Your-Own Periodic Table activity to arrange cards with properties (without the name of the element) into a (hopefully, periodic) table of elements.	
M + A	3. The teacher will them pose the question, *what is periodicity?* After discussing periodicity, the teacher will review the periodic table trends of reactivity, atomic radius (both atomic and ionic), electronegativity, and ionization energy.	
M	4. Students will review electrons and how we understand their placement in the atom through the Heisenberg Uncertainty Principle through the floorplan probability activity (reference: Robertson, William. Stop Faking It! Finally Understanding Science So You Can Teach It: Chemistry Basics. Pg 40-44. Arlington: National Science Teachers Association, 2007. Print.)	The teacher will circulate around the room, redirecting and supporting students as necessary.
A + M	5. Students will finally write electron configurations of both atoms and ions, relating electron configurations back to periodicity and bonding tendencies.	

Performance Task Rubric

	Emerging	**Developing**	**Proficient**	**Advanced**
Background: *Support the Hypothesis & Analyze the Issue* [Adapted from ISSN Standard SCI9-10.INV2.SOURC]	Gathers background information from a limited number of sources (1-2) and begins to analyze these sources	Gathers background information from a variety of sources (2-3) and ***compares and analyzes*** it, with results ***beginning to support the hypothesis***	Gathers relevant background information from a variety of sources (2-3) and ***compares and analyzes*** it, providing ***support for most issues raised by the hypothesis***	Gathers relevant background information from a variety of sources (3-4) and ***compares, analyzes, and evaluates*** it, providing ***clear support for the hypothesis***
Hypothesis: *Predict & Describe*	Formulates questions about a science issue	Formulates questions about a significant science issue through a developed hypothesis	Formulates and refines questions about a significant science issue through a ***clearly constructed, specific, and focused hypothesis***, explaining the ***purpose of the study***, and the ***range of the independent***	Formulates and refines questions about a significant science issue through a ***challenging, intriguing hypothesis*** that takes a defensible stand, justifies discussion, and introduces new ideas (including explaining the

[Adapted from ISSN Standard SCI11-12.INV1.QUSTN]			***variable*** to be tested	***purpose of the study***, the ***range of the independent variable*** to be tested, and other any ***other important parameters***)
Procedures: *Experimental Design* [Adapted from ISSN Standard SCI11-12.INV4.XPRMT]	Designs an experiment that is related to the stated hypothesis	Designs an experiment that is relevant to the stated hypothesis, ***testing the range of the independent variable***	Designs an experiment that offers a ***detailed method for investigating and testing the hypothesis***, using appropriate technology, ***testing the range of the independent variable and control(s)***; the explanation of the procedure ***allows for replication*** by other scientists (including necessary materials, constants, and other important parameters)	Designs an experiment that offers a ***comprehensive method for investigating and testing the hypothesis***, using appropriate technology, ***testing a purposeful, reasonable range of the independent variable and control(s)***; the explanation of the procedure ***promotes replication*** by other scientists (including necessary materials, constants, and other important parameters)
Data: *Raw and Charted* [Adapted from ISSN Standard SCI11-12.COMM2.VSULS]	Presents data with visual representations that mostly support explanation of science issue and experiment AND display of data follows most conventions of scientific communication (i.e. appropriate formatting, labels, units, etc.)	Presents data with visual representations that ***support explanation of the science issue and experiment*** AND research presentation ***follows most conventions of scientific communication*** (i.e. appropriate formatting, labels, units, etc.)	Presents data with visual representations that ***enhance understanding of the science issue and experiment*** AND research presentation ***applies most conventions of scientific communication*** (i.e. appropriate formatting, labels, units, etc.) to express ideas and learning	Presents data with professional visual representations that illustrate relationships between variables that ***enhance understanding of the science issue and experiment*** AND research presentation ***consistently applies conventions of scientific communication*** (i.e. appropriate formatting, labels, units, etc.) to express ideas and learning and enhance audience understanding
Analysis: *Process and Describe Data AND Conclude* [Adapted from ISSN Standard SCI11-12.PERS2.DATA]	Identifies ***patterns or relationships in the data*** (specifically, explaining the ***effect of the manipulation of the independent variable*** on the dependent variable and ***comparison with control***) with limited mathematical analysis and few errors, identifies and discusses experimental error, refers to hypothesis	***Analyzes patterns and relationships in the data*** (specifically, explaining and beginning to interpret the ***effect of the manipulation of the independent variable*** on the dependent variable and ***comparison with control***) with mostly correct mathematical analysis, identifies and interprets experimental error, ***concludes by evaluating hypothesis***	***Evaluates patterns and relationships in the data*** (specifically, explaining and interpreting the ***effect of the manipulation of the independent variable*** on the dependent variable and ***comparison with control***) with mathematical analysis, identifies and interprets experimental error, ***concludes by evaluating hypothesis based on evidence***	***Interprets complex patterns and relationships among multiple variables in the data*** (specifically, explaining and evaluating the ***effect of the manipulation of the independent variable*** on the dependent variable and ***comparison with control***) with mathematical analysis, identifies and interprets experimental error and offers solutions to

			from data	minimize future error, ***concludes by evaluating hypothesis based on evidence from data*** and explores intended and unintended consequences